I - F. Towards an "Expert" Maternity Computer System

A Discussion Document
concerning the Further Development
(at that time) of the Protos Maternity Computer System
as a Rule Based "Expert" System

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Any Comments, Criticisms, Corrections
or Suggestions for Improvement very welcome

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B. Preface

Good maternity care, among many other factors, significantly depends upon the following:

1. Careful IDENTIFICATION for each pregnant woman of a set of especially relevant INDIVIDUAL CHARACTERISTICS.
2. Using such characteristics as a BASIS, both for her GENERAL CARE and with regard to certain SPECIFIC ACTIONS
3. RECORDING what actions may or may not have been taken.
4. COMMUNICATION regarding such actions with all relevant parties.
5. AUDITING the above.

This document is intended to stimulate a continuing discussion on how maternity computer systems might, now and in future, best be able to assist in each of these aspects of the maternity care process

C. Introduction

High/Low Risk or Special Features?

Individual characteristics are sometimes described as "Risk Factors" *(e.g. Elderly Primip, Insulin Dependent Diabetic, Previous Caesarean Section, Rubella Antibodies absent, Hepatitis B Carrier, Previous Small for Dates Baby, Baby at increased risk of Tuberculosis etc)*

On the basis of such factors there has been a tendency for expectant mothers to be labelled as "High Risk" or "Low Risk", sometimes even using a formal scoring system. It has subsequently become clear that such a mathematical or simplistic approach, while useful for retrospective audit and analysis, has severe limitations in the encouragement of good individual maternity care. Too often such an approach both causes unnecessary anxiety about risks which cannot be altered by any specific intervention and also does little to encourage the clear documentation of those specific interventions which might be useful for each individual mother. The concepts are usefully explored in the chapter entitled "Formal Risk Scoring" in "A Guide to Effective Care in Pregnancy & Childbirth" (See References and possibly attached Photocopy)

Instead, at least in casenotes held by expectant mothers, there is now a tendency to provide space for a more holistic view under the heading "Special Features" This is intended not only to allow the documentation of traditionally recognised Risk Factors *(e.g. Previous Caesarean, Elderly Primip, Fractured Pelvis)*, but also to encourage the highlighting of more general comments *(e.g. Previous Psychologically Traumatic Birth/Very Anxious Mother, Unsupported Single Mother, Interpreter needed etc.)*

It is also intended to sound less threatening to the mother than the heading "High/Low Risk"

At the same time, even with existing paper-only systems, various means are used to encourage specific actions regarding certain specific "Risk Factors". This is encouraged by district guidelines or protocols. It is also attempted in the care of individual pregnancies, occasionally by the printed wording of the casenotes, more often by the use of rubber stamps or labels in individual case records *(e.g. Rhesus Negative. Anti-D needed)*, or by hand-written comments *(e.g. "Paed SHO to be present at delivery" etc)*

Computers, Special Features and Specific Risks

Computers can become involved in this process in two complementary ways:

A. HIGHLIGHTING SPECIAL FEATURES

Significant items from the data entered onto the computer at the initial assessment and subsequently through the pregnancy can be selected and highlighted both on screen and in paper outputs.

B. ACTION SUGGESTIONS BASED ON SPECIFIC RISKS IDENTIFIED

Using a carefully documented set of "expert" rules, the computer can be used more precisely to identify certain particular risks, to suggest specific actions, and then, when possible, to record and communicate regarding what actions might or might not have been taken.

In computer terms, much can be achieved in a relatively simple manner by highlighting data known to the computer, and some progress has already been made in this area. This discussion document is concerned with the second, more complex area.

MASSIVE POTENTIAL: NEED FOR CLASSIFICATION

A list of all the potential Action Suggestions soon becomes very large, and some system of classification is quickly required. Since the aim of the process is to provide appropriate Action Suggestions at an appropriate time it seems best to concentrate first on this aspect. (The justification for this approach is more fully explained below)

TIMING OF SUGGESTIONS:

A. INITIAL ASSESSMENT/SCREENING
Suggestions for Immediate Action at Initial Assessment (includes Screening Suggestions)

B. ANTENATAL CARE SUGGESTIONS

C. BIRTH MANAGEMENT SUGGESTIONS

D. MOTHER at Birth and at Post-Natal Discharge

E. BABY at Birth and at Post-Natal Discharge

Although all suggestions are classified by the time of their implementation, that does not mean that they can only be listed and/or output at that time. For example it would be appropriate for those Birth Management Suggestions which have been identified at the initial assessment to be displayed and possibly to be printed out at that time, and other times both before and after the birth itself.

Kate Guthrie and others listed about 100 action suggestions in an article entitled ""History taking by computer" (See references) and a great deal of further work has taken place in Hull on a set of suggestions based on the initial assessment (booking history) of the Protos maternity system. On the whole this has involved the identification of a relatively simple TRIGGER DATA ITEM, and the printing out in the initial assessment summary of the appropriate ACTION SUGGESTION, without any later use of the identified items as the basis for further inputs and outputs in the computer system.

Using Kate Guthrie and Richard Lilford paper as the basis, I have done some further work, reclassifying her list under the headings A. "Action Suggestion", B. "Because of the Risk of", C. "Trigger Item(s)," and D. "When (potentially) entered on the computer" i.e. as suggested above, primarily re-classifying all their suggestions on the basis of the time when any suggestions would be relevant. This I have set out in a document entitled "RIsk assessment and the potential for computer generated action suggestions regarding the EXPECTANT MOTHER" and a similar document regarding the Care of the NEONATE" Both these require further work but are available on request as they have so far been created.

POST-NATAL COMPUTING THAT IS USEFUL TO THE USER

My own main interest at present has been to try to improve the current Post-Natal module.

In the labour ward the tedious work of data entry is made worthwhile because of the resultant reduction in form filling. At post-natal discharge, at least in the present version, there is far less return to the midwife for her work with the computer, and, indeed, several attempts to introduce post-natal computing (using other systems) have in the past failed for this very reason. The best way to give a greater return to the midwives in the post-natal ward seemed to be by maximising the computer's potential to provide reminders or "Action Suggestions".

As the analysis became more detailed it also became clear that use of a risk based approach had an extra potential for reducing the work of the post-natal midwife as it would allow several questions to be skipped when they were not relevant to the individual mother or baby *(eg. no need to ask about giving Anti D to a Rhesus Positive mother, or Rubella Vaccination to a mother who has Rubella antibodies etc.).*

SELECTING SUITABLE ITEMS

On checking through the current birth and post natal input protocols and paper outputs, it became clear that several items had already been incorporated which involved the use of a simple rule based approach. Several more items were then recognised as also being suitable for early incorporation into the post-natal module, with the following examples so far considered;

For the MOTHER,

a) **Rhesus Anti-D Injection** for Rhesus Negative mothers without antibodies
b) **Rubella Vaccination** for those mothers without Rubella antibodies
c) Six week **Post-natal hCG** on those who had a past history of hydatidiform mole .
d) **Full Blood Count** whenever there is a risk of Anaemia, eg. after a C/S or a PPH etc
e) **Antibiotics,** for example after a Caesarean

For the BABY

a) **Vitamin K** to prevent haemorrhage
b) **PKU/Hypothyroidism** testing
c) **Cord Blood Tests** when Maternal Antibodies have been found
d) **Hepatitis B Vaccination** for those at Risk,
e) **BCG** for those with a TB Risk,
f) Selective **Audiology** for those neonates considered to be at higher than average risk,
g) **Renal Scan** of the neonate when a pregnancy scan had shown possible renal problems
h) Selective **Hip Scanning** for Congenital Dislocation of the Hip (CDH)
i) **Prophylactic Antibiotics**, for example for those at risk from prolonged rupture of the membranes

PROCESS NOT JUST AN EVENT: NEED FOR FURTHER ANALYSIS

It subsequently became clear that, if the potential of the computer were to be properly used, there was a need for a more careful analysis of what was going on.

In a "Labour Ward only" maternity computer system, certain characteristics had quite simply been used to trigger certain Action Suggestions. This relative simplicity seemed also to be true of the Booking Protocols and Booking Summary as so far developed. Indeed on both occasions the computer was almost exclusively used for the simple recording of past events *(e.g. History of Previous Caesarean, Method of Birth)* with a some of these being used as the simple trigger for a suggested action.

But as soon as the computer system is used on more than one occasion in the same part of the birth process (*for example at birth and also at the post-natal discharge; or at the initial booking and also at birth*), it has gradually become clear that, for each individual item of potential advice, the whole of the following sequence needed to be carefully identified and documented for each Action Suggestion.

D. Need for Full Documentation

1. BASIS

Very careful documetation of the basis for the Expert Advice

2. TRIGGER CHARACTERISTICS

The majority of triggers are be identified through the answers to protocol questions (at the initial assessment or at various other times) Most such items will be identified as the direct result of a particular response to a single question. A few trigger situations may only be identified only as a result of a more complex calculation *(e.g. a previous baby being born at 35 weeks being smaller than the 5th centile for a mother of her height and weight, having a male child in her first pregnancy etc.)* or using a simple algorithm *(eg. Anti-D only if the mother is Rh Neg AND has no antibodies)*

Some risks (and associated action suggestions) are present for almost all pregnancies. *For example, whenever a livebirth occurs it is generally agreed that there is a risk of a baby with Phenylketonuria or Hypothyroidism and a blood test is needed for every baby.* No specific Trigger Item was needed for such risks to be present.

3. TIMING OF INPUT

Naturally the computer can only be useful in those circumstances where there is an reasonable opportunity to enter the necessary trigger data items, and the ideal time for such an input needed to be documented, both with the system as now in use, and also in a future ideal system. *For example, with regard to Rhesus Negative mothers, using a current "Labour Ward Only" system the Rhesus group of the mother can only be entered as part of the Present Pregnancy Summary at the time of birth. Within the reasonably near future it ought to be entered as part of the Initial Assessments Blood Tests or as part of a current Pregnancy Status Screen. Ideally in future it ought to be automatically entered from a pathology system.*

4. TIMING OF ADVICE/OUTPUT

Items identified as "Risk Factors" will often be so identified in order to act as a trigger for certain specific Action Suggestions. Such suggestions often need to be made at a specific time. *For example, if Rubella Antibodies are found to be Absent - as identified from blood tests taken at the time of the Initial Assessment - then there is a need for Rubella Vaccination for the mother to be suggested soon after birth. There is no point in the computer making any suggestions in the screen or paper output other than in parts of the computer program concerned with the mother after the birth of the baby.*

5. ACTION SUGGESTIONS AND ACTIONS TAKEN

For each identified risk, the wording of the Action Suggestion naturally needed to be appropriate to data which might or might not already be on the computer; *For example, if the result of the mother's blood group was known, at or before birth, to be Rhesus negative, then a simple suggestion was needed that Anti-D was needed, but if the Rhesus group was unknown then the relevant suggestion would be "Urgent Rhesus Blood Group Result needed"*

Other items turned out to be much more complex, especially for items such as the PKU/Hypothyroidism test, which might or might not have been done before discharge or by the time of transfer from the midwife to the health visitor. Under such circumstances, almost each option for each different printout required a different wording. (See detailed documentation) This is the area which caused the most complexity

Overview of "Expert" Assistance/Advice

INPUT	Personal Data, History, Examination, Test Results etc *Free text cannot be used (except possibly under a single specific question)*
	▼ ▼ ▼ ▼ ▼ ▼ ▼
SPECIAL FEATURES	▼ ▼ General Comments e.g. Diabetic, Previous Traumatic Birth etc *(Could also allow the display of the free text mentioned above)*
TRIGGER DATA ITEMS	Specific Data Items which allow the identification of Specific Risks *e.g. Rubella antibody absent, History of Anaemia*
	▼ ▼
SPECIFIC RISK IDENTIFIED	Specific identification of an increased risk of a particular problem *e.g. No Rubella Antibodies therefore risk of Rubella in next pregnancy* One action suggestion may be based on several different Trigger Items *e.g. Anaemia risk may be identified when there has been a PPH, or a History of Anaemia, or a Caesarean.* Some risks may be relevant to the computer program but may not have any associated Action Suggestions *e.g. Risk of Complications of an Epidural.*
	▼ ▼
ACTION SUGGESTIONS	Specific suggestion(s) based on an identified risk *e.g. Rubella Vaccination needed or Haemoglobin blood test needed*
	▼ ▼
ACTIONS TAKEN	At the time when any particular protocol is entered what actions have so far been taken *e.g. has the rubella vaccine been given* What actions have been suggested but are thought not to have been appropriate for a particular mother or baby *e.g. Mother refused vaccination*
	▼ ▼
ACTIONS STILL PROBABLY NEEDED	What actions are outstanding and may need to be included in the printout for the community midwife, GP or health visitor *e.g. mother went home before the Rubella vaccination could be given*

AIM & BASIS FOR EACH ITEM

As each item became documented in the ways listed above it became apparent that such complexity always needs to be based on a very clear view as to the overall aim of any advice, and also of the expert basis for any such advice.

This part of the documentation becomes even more important whenever there is no national consensus on what the expert view should be. So far, such local variations have tended to affect the actions taken rather than the advice given *(For example on the dose and route of Vitamin K)*, and, as such, do not seem to have caused any development problems. In future however, as the complexity of expert advice increases, so it seems inevitable that there will be more fundamentally different local opinions. And even if, as seems likely, it does not prove possible to allow for major local variations to be incorporated within the present computer system, the debate about the design of the generic system must depend on very clear documentation as to what exists and what changes might be proposed. (See below for a fuller discussion regarding local variations, both within the constraints of the present system and with regard to future development)

Documentation

In summary, it became clear that there was a need for clear generic documentation under each of the following headings for each proposed expert item:

A. Expert Basis

Overall Aim and Expert Basis for the proposed Advice, References.

B. Logic

Trigger Data, Timing of Availability and Computer Entry of Trigger Data

Timing of Advice, Actual Advice, Action taken or not taken and Reason for that particular response.

Audit proposals.

If an Action Suggestion is of sufficient importance as to be on the computer, and if the action taken is also entered on the computer then it seems likely that it will be worth auditing the compliance with each suggestion.

C. Implementation

Once the basis for a proposed item of expertise had been clearly documented, there was also a need to set out in detail how such advice might be implemented in the Protos system.

For a progressively increasing number of items, such detailed documentation, both of the Basis and of the Proposed Implementation is gradually being set out in a separate paper entitled "Rule Based Expert Maternity Computer System: Detailed Documentation"

E. Display of a List of Risks Identified

Need for Jumping

In the current system, the following question is asked regarding all mothers.

"Rubella Immunisation Given?

This is preceded by a display of the result of the Mother's Blood Test at Booking.

And if the display showed "Rubella Antibodies: Present", then it would be expected that the response to the main question would be: "Not needed"

If from data already on the computer it was known that Rubella Vaccination was not needed, then it would reduce the workload for the user, and might avoid an unnecessary item in the database, if the Rubella Vaccination question could automatically be jumped over in the post-natal protocol.

And, as the number of such items is likely, in time, to increase, it seemed likely to be increasingly important to avoid asking questions about actions which would not be relevant to a particular pregnancy.

Grouping risks identified together?

In order to minimise mistakes and also to allow the user to feel more in control, it seemed right, If such jumping were to become inbuilt, to provide an opportunity to review and potentially to modify each risk so far identified by the computer. Only in this way would there be an opportunity to override such jumps. And because it was thought that such a degree of complexity might be confusing if randomly used at different parts of the protocol, the sequence of questions was for a time re-arranged so that all sections involving rule based expertise were grouped together all in one section regardless of their nature *(i.e. injections, scans, referrals etc.)* An opportunity was then provided to review and if necessary to alter the set of identified risks at the beginning of that special section.

Subsequently it seemed better to provide the opportunity to review and if essential modify the Risks Identified list at the very beginning of the whole protocol, rather than before a special expert section. If done in this way it then seemed better for individual questions to go back to their original more logical sequence.

Display of Risk List

It is suggested that this would work as follows: First a list of all those Risks Identified which might be relevant to questions asked later in the protocol would be displayed on screen. If possible it would also be good to display the basis for the identification of that particular risk at the same time. Then user would be asked if they saw a need for any revision to the list. It ought to be extremely rare for such any such modification to be necessary. However on such occasions there would then be an opportunity to use a specific protocol allowing identified risks to be added or subtracted from the active list, before continuing with the rest of the protocol.

RISKS CAN BE ADDED, NOT SUBTRACTED

At first it was then proposed that the user would be free either to add, or to subtract, from the list of Risks Identified. But, if it seemed inappropriate for the care of a particular mother, the user is quite free not to follow any action suggestion (as long as the reason is properly documented on paper or on the computer) And allowing the user to subtract risk items would leave the confusion of Risk Triggers without associated Risks Identified. It seemed therefore better to allow risks to be added but not subtracted, at least at this stage of development.

ADVANTAGES AND DISADVANTAGES

The advantage of such an arrangement would be that it would allow the user to feel more in control. The disadvantage would be the opportunity for human error in overriding clearly set out protocols. Despite the potential for error the best solution would seem to be to allow overriding by addition while making it relatively difficult to achieve.

Modification of Risks Identified

To be incorporated near the beginning of each relevant protocol. At present proposed as part of the following: A. MOTHER i Just after birth (Third Stage Protocol) ii Postnatal discharge
B. BABY i Just after birth (Baby Protocol) ii Postnatal Discharge.

***** Administration *****

***** List of Risks Identified *****

RISKS IDENTIFIED	BASIS
Anaemia	Postpartum Haemorrhage History of Anaemia
Hypertension	P.E.T.
Infection	Caesarean Section

Q10. Do you wish to add to this list? No/Yes

▼ ▼

If No ▼ If Yes ▼

▼ ▼

▼ Specific set of questions regarding all those

▼ Risks which are relevant to the Protocol

▼ currently in use. Option to change any "No"

▼ to a "Yes" *e.g. Risk of Rubella added*

▼ ▼

▼ ▼

▼ ▼

Rest of Protocol eg.

M I 15, Rubella Vaccination ZMPNd

Given
Failed to be given
Refused
etc

Because the original list of risks did not include Rubella this question would be skipped unless the Rubella Risk had been added after the first question above had been answered "Yes" and the risk added to the list of Risks Identified

WHY "RISKS IDENTIFIED"

In the "expert" progression: "Trigger Factors" >>>>> "Risks Identified" >>>>> "Action Suggestion" >>>>> "Action Taken", why allow an intervention at the "Risks Identified" stage?

It would be very difficult, and probably confusing, for the ordinary user to be encouraged to go back and modify the "Trigger Factor" *(which could for example have been incorrectly entered right back in the time of the Initial Assessment)*

So far it seems reasonably certain that, in any expert computer system, each "Action Suggestion" is totally dependant on and linked with a particular "Risk Identified". For this purpose they can be treated as a single entity. (In life we often identify a "Risk" without a linked "Action Suggestion" but I'm fairly sure that as far as a computer system is concerned such unlinked "Risk Identification" is not worthwhile; although I am prepared to accept that further development may show that I'm wrong, especially with regard to the ongoing care of individual women)

Regarding the next stage in the progression, the user is always free to answer "Inappropriate" regarding any "Actions taken" questions. Hence the logic of only allowing modification at the stage of "Risks Identified"

Sets of Risk Lists

In order to avoid going through a long list of all the Risks Identified regardless of their relevance in a particular context, *(for example going through all the risks identified for the Mother when going through the Baby's Post-Natal Protocol),* it then became clear that it would probably be worth attempting to group risks in sets which could then be appropriately selected from within particular protocols. This confirmed that the best way to classify the massive potential numbers of expert items was by the timing of the advice being given.

Thus when doing the protocol for a baby either at birth or at the time of post-natal discharge, only those risk items relevant to the baby should be checked. Following this approach it has, so far, seemed best to group risks as follows:

BABY: Those Risks Identified as relevant only to Action Suggestions regarding the care of the neonate *(e.g. CDH Risk, Hearing Risks etc)*

MOTHER: Those Risks relevant only to Action Suggestions regarding the care of the mother after the birth has taken place *(e.g. Rubella Vaccination, Rhesus Anti-D injection)*

Assuming that the same logic is likely to apply to "Risks Identified" during pregnancy it seems quite probable that there will in future also be a need for similar sets of risk protocols as follows:

INITIAL: Those Risks relevant only to Action Suggestions regarding the care of the expectant mother and her intra-uterine fetus at the time of the initial assessment, especially with regard to screening suggestions *(e.g. Haemoglobinopathy checks, Notification of a particular Anaesthetic Risk etc)*

ANTE-NATAL: Those Risks relevant only to Action Suggestions regarding the care of the expectant mother and her intra-uterine fetus during her pregnancy *(e.g. Monitoring of Fetal Growth by Scan, Extra checks for Maternal blood Antibodies etc)*

BIRTH: Those Items relevant only to Action Suggestions regarding the care of the Mother and the Baby during the process of Birth *(e.g. Epidural requested, Need for a Paediatric or Obstetric Registrar to be present at the birth etc)*

GENERAL: Those Risk Items relevant to Action Suggestions regarding the care of the mother both during pregnancy and the birth and post-natally *(e.g. Insulin Dependent Diabetic, Higher than average risk of Deep Vein Thrombosis etc)*

From the analysis so far done the need for the first two categories seems well established. It remains to be seen if the other suggested subdivisions prove to be useful. Possibly the "General" category may be superfluous?

Computer Requirements

Computers above all need simplicity. They cannot "think"!!

This causes problems since some "Trigger Items" are likely to lead to more than one "Specific Risk Identified/Action Suggestion" pairs *(e.g. The identification of a mother as being at risk because of her insulin dependent diabetes is likely to generate several different "Risk Identified/Action Suggestion" entities)* In addition some "Risks Identified/ Action Suggestions" may arise from more than one "Trigger Item" *(eg. "Risk of Anaemia" may be triggered by "Post Partum Haemorrhage", and/or "Caesarean Section" and/or "Past History of Anaemia")*

To allow the proposed display listing of "RISKS IDENTIFIED" and "BASIS FOR IDENTIFICATION" it is suggested that there should be in the computer program a Boolean Yes/No data item for each pair identified, together with an associated list of possible "Trigger Items". For each risk identified, the computer would then look through it's data base and pick out and display any related trigger item from the documented list. Possibly a special Data Dictionary would be helpful.

At first it was thought that there would be no point in identifying a risk unless there was an associated action suggestions. While this may be true regarding individual maternity care, for the entry of data for later audit, it may still be useful to identify risks without any associated action suggestions. For example: All those women who have an epidural are at risk from specific epidural complications. When there has not been an epidural then there is a need to skip past the part of the protocol which asks about epidural risks. It remains to be seen if it would be useful for such risks to be included in a data dictionary or if they can be dealt with quite simply by some cql programming at the appropriate point in the protocol.

Initial pre-set values

The answer to all the questions in each protocol will be automatically created for each new pregnancy. With a few exceptions (such as the need for PKU/Hypothyroidism testing) all answers will start as negative, but will be changed when appropriate as a result of the answers entered from other protocols.

Use of risk protocols by themselves

Although there is no theoretical reason why each set of risk protocols should not be accessed directly, it seem likely that such a facility might never be found to be useful by itself, and it might not therefore be necessary for them to be included in the Tasks, Protocols list.

Sample Relationships

TRIGGER DATA	RISK IDENTIFIED	ACTION SUGGESTION
	Possible CPD	Pelvimetry
Caesarean Section	Infection	Prophylactic Antibiotics
Post Partum Haemorrhage	Anaemia	Post Natal Full Blood Count
Past History of Anaemia		
(None needed. All babies at risk)	Hypothyroidism in baby	PKU Test
Epidural	Complications of Epidural	*(None except for data entry for Audit)*
Gestation less than 32 weeks		
Birth weight less than 1.5 kg	Possible Hearing Problems	Audiology Testing
Apgar of 3 or less at 5 minutes		

F. Related Concepts and Opportunities

The pattern whereby the user can review and add to the list of "Risks Identified/Actions Suggested" would seem also to be relevant to tow other aspects of patient care.

A. PATIENT INFORMATION LEAFLETS

At the end of each set of input questions it would be possible to identify all those patient information leaflets which might be useful at that stage of a patient's care. For example, from the information in the computer system at the end of the hospital postnatal episode, it might be possible to identify the following leaflets as being relevant to a particular mother: - Your Breast Fed Baby, Possible Hip Problems, Possible need for BCG etc.

The mother might already have one or other of these leaflets, and there may be relevant ones where the basis for their being needed is not something on the computer. It would therefore be useful if prior to any leaflets being printed out the computer user could have a list of those suggested and an opportunity to add or subtract from the set of leaflets due to be printed out by the computer.

B. STAFF GUIDELINES

In a similar fashion it will also be possible to identify staff guidelines/signposts relevant to a particular patient and to print out more or less than the set suggested by the computer. For example at the time of the initial assessment and on the basis of data entered at that time the computer may suggest the following specific guidelines should be printed: "Management of Epilepsy in Pregnancy", "Guidelines regarding the management of pregnant women with a history suggestive of hyperthermia" etc. The user might decide that they are already well aware of the management of epilepsy but, being very new to the district, might not have known what the local policy was with regard to serum screening, and the phone number of the person from whom advice on the subject might be helpful

G. Possible Future Developments

All that has been suggested so far should be practical within the known abilities of the current Protos system. Two related matters, relevant to future development now need to be considered.

A. OPENNESS OF THE SYSTEM/CONTROL BY THE USER

A rule-based computer system depends on the clear definition of a number of small steps in a process. As proposed above, the only step which will be accessible to the user is the ability to review and, if desired, to add to (or possibly subtract) from a displayed list of "Risks Identified" All the other steps are hidden and automatic. In an even more complex system, the user might in theory also wish to know what computer held data has triggered a "Risk Identified Items" He might then wish to review and possibly revise such trigger data. He might also wish to review and possibly revise the advice which the computer is going to give at a later stage in the process. Finally he might wish to enter comments on why the automatic process has been tampered with. The ability to do this easily will require further work on the design of the Protos software, possibly only making sense as as part of the move to a full Windows environment.

Such freedom would allow a much greater risk of error, with the potential for important advice to be over-ruled.

B. LOCAL VARIATIONS IN THE GENERIC RULES

The ideas set out above have resulted in a rule based system which depends on a significant quantity of detailed computer programming. Some simple local variations have been incorporated where these only affect the actions taken rather than the advice given but the scope for this approach is limited. In future there seems likely to be a consumer demand for more fundamental local variations in the rules themselves. Under the present system this would involve major local programming changes of a sort which has proved impractical on an individual site basis. This is because any non-generic system becomes impossible to upgrade without so much time and work as to be financially impossible both for Protos and the local site.

Ideally a there should be a generic way to develop and to alter the expert rules, possibly even on a limited local basis. While this may prove to be impractical, the concept needs to be explored.

NOT UNIQUE

Both the above concepts are not unique to the Protos maternity system, and before trying to incorporate such ideas into the maternity system it would be worth seeing what progress has been made by others who are active in this field of development

H. Conclusion

This discussion is an attempt to see how a rule based expert system (based on the analysis of A. Special Features/ Risk Factors/Risks Identified, B. Trigger Data, C. Action Suggestions and D. Action taken or not taken) could best be incorporated in the Protos maternity computer system, especially as a start, into the Post-Natal Module.

For those who might argue that this does not add up to what they thought a computer "expert" system would be, I would suggest further reading, such as that given in the list of references. In summary computer expert systems only consist of two basic types, those like the one we are proposing to develop, which are based on "Rules" and those based on Bayesian probabilities which would probably have a very limited application in a maternity system.

Computer hardware and software limitations mean that further development in this area will, for several years, not be as user friendly as might be desirable. Much better screen resolution and the upgrading of the Protos system onto a future version of something like Windows will be required.

Nonetheless it seems reasonable to hope that any detailed documentation done at this stage will not only allow the system to provide much that is immediately useful, but will also stimulate the ideas necessary future development.

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"Formal Risk Scoring" in "A Guide to Effective Care in Pregnancy & Childbirth"
2nd Edition. Oxford University Press 1995

Expert Systems

Appendices

I Proposed text for incorporation into relevant protocols

It is proposed that a version of this text be inserted near the start of each relevant protocol.
At present these will include the following:

A. MOTHER.	i. MP_CON (Mother just after Labour)	ii. MP_TPM (Mother - Postnatal discharge)
B. BABY	i. MP_BABY (Baby just after Birth)	ii. MP_TPN (Baby - Postnatal discharge)

Subheading, RISKS IDENTIFIED
Document
Based on information already on the computer, the following risks have so far been identified as especially relevant to this stage of this mother's care:
Enddocument

RISK IDENTIFIED	BASIS
Anaemia	PMH of Anaemia PostPartum Haemorrhage Caesarean
Hypertension	P.E.T.
Anti-D Rhesus Incompatibility	Rhesus Negative + No anti-D Antibodies
Rubella in future pregnancy	Rubella Antibody negative

See discussions in main document as to how it should be possible to achieve this table
The questions you will be asked in this protocol will depend on the above list.
Later computer printouts will then depend both on this list and on your answers to the questions below.

Z1. Do you wish to add to this list

No
Yes

Only change items when this is important.

You do not have to follow the computer Action Suggestions if they are inappropriate for the care of an individual mother; BUT when you do something differently it is very important to write down - in her casenotes - why !!

help
With regard to a limited but ever increasing list of risks, the computer, using information previously entered, has been programmed to avoid unnecessary questions, and to provide relevant action suggestions in it's printouts. If for some reason one of the risks which the computer has in it's program has been missed out, this section allows you to add that risk. For example, if you happen to know that this mother is at risk for Rubella in her next pregnancy, but "Rubella Risk" is not on the list, then, if you do not modify the list of risks now, the computer will not ask if you have given Rubella Vaccination, and, if she is going home before there has been time for this to been given, it will not be suggested to the midwife and health visitor that a Rubella vaccination might be needed.

If instead you have used this opportunity to add that risk to the list then the computer will ask the right questions and provide the right outputs.

Naturally the computer does not have a program for every risk, so that if the risk is not one that the computer has a program for, then it cannot be added now but should be suggested to Protos as a possible future addition.
endhelp

If Z1 equals "No" jump to

cql
'Run appropriate Risk Protocol and come back here
endcql

I I. Risk Topics currently being analysed in full detail

List of those Risks Identified/Action Suggestion Pairs which have so far been identified as needing detailed analysis because they involve more than relatively simple Trigger Data, and immediate Action Suggestion(s), without any computer follow-up on Action(s) Taken or deemed inappropriate.

In time, for every "Risc Identified/Action Suggestion" pair - even simple ones, there will be a need for careful documentation of the evidence (good or poor) which has led to their being incorporated in the Protos maternity system.

The actual documentation is available separately.

		Acorn Filename (-B = Basis, -P = Protos Computer Implementation)
A. INITIAL ASSESSMENT/SCREENING		
B. ANTENATAL CARE		
C. BIRTH		
D. MOTHER		
1.	Rubella Vaccination	Rubella
2.	Rhesus Negative Anti-D Incompatibility Prevention	Rhesus
3.	Hydatidiform Mole Risk	Mole
4.	Anaemia	Anaemia
E. BABY		
1	Vitamin K Deficiency Risk. A. At Birth B. Post-Natally in Breast-Fed Babies	VitK
2.	PKU/Hypothyroidism Risk	PKU
3.	Maternal Antibodies, Blood Incompatibility Risk	AntiB
4.	Hepatitis B Risk	HepB
5.	Tuberculosis Risk	TB
6.	Hearing Risk	Hear
7.	Scan showing Renal Problems	Renal
8.	Congenital Hip Dislocation Risk	CDH